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ABSTRACT

This document, the first of two instructional modules on the topic of energy, is designed for secondary school students of English as a second language (ESL). The theme relates directly to the science and geography programs at the intermediate and senior levels, and the materials are designed as an overview and introduction to a complex subject at a linguistic level accessible to the ESL student. The objectives are for students to (1) know that energy can take many forms, (2) identify basic energy forms in everyday use, (3) know that energy can be converted into other forms; and (4) realize the need for energy conservation. English communication and organization skills are encouraged through reading and listening, expressing use and need, using the conditional forms of verbs to express hypothetical situations, describing spatial organization in pictures, and classifying information. The teacher's guide consists of an introduction to the materials, procedures for the accompanying tape-filmstrip presentation, follow-up activities, a list of useful concepts and terms, references and resources, and an answer key to student worksheets. (MSE)

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ESL/ENERGY MODULE 1

THE MANY FACES OF ENERGY

TEACHER'S GUIDE

Joan Howard, Maria Fröhlich,
and Bill Marshall

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The Module: The Many Faces of Energy

GENERAL OBJECTIVES

The Many Faces of Energy is the first of two modules on the topic of energy, a theme that relates directly to the science and geography programs at both the intermediate and senior levels. The module is designed not as an in-depth study of this vast theme, but as a general overview and introduction for the ESL student to a complex and difficult subject. We have tried to present this very difficult content material at a linguistic level that is accessible to the ESL student, and to provide opportunities to review and reinforce the content by means of communicative language practice and interesting project activities.

By the end of this module your students should:

- know that energy can take many forms
- be able to identify basic energy forms in everyday situations
- know that energy can be converted from one form to another
- realize the need for conservation of energy resources

English communication skills and organizational skills will be encouraged through:

- reading and listening
- expressing use and need
- using conditional verbs to express a hypothetical situation
- describing pictures using principles of spatial organization
- classifying information

We hope that by presenting students with accurate factual information on forms and sources of energy and other related concepts and by giving the students practice in using the appropriate vocabulary, structures, and functions to express that information, *The Many Faces of*

Energy will help them overcome some subject-related difficulties and thereby allow them to enter and participate more fully in regular classes with their English-speaking peers.

COMPONENTS

- Color filmstrip presenting a basic introduction to some common forms and sources of energy, as well as relevant vocabulary and terminology.
- Audiocassette tape to accompany the filmstrip (Side 1), and to provide listening comprehension exercises (Side 2).
- Set of 10 photographs (8" × 10").
- Set of 25 student reading booklets, *Energy for the Future*.
- Duplicating masters for 19 student worksheets.
- Teacher guide.

TARGET AUDIENCE

The Many Faces of Energy is designed primarily for ESL secondary school students at an intermediate and advanced level of English competence. It has been successfully tested in a number of ESL/science and ESL/geography classes in grades 9, 10, and 11. As language abilities vary widely in ESL classes, teachers may also find the module suitable for individual, group, or class use at other grade levels. It is assumed, however, that all students who use the kit will have completed an introductory course in English.

Students at the grade 9 or 10 level who are native speakers of English but have difficulty expressing themselves can also benefit from the subject-related practice exercises to improve their English communication skills.

Part A: Tape-Filmstrip Presentation

The filmstrip and accompanying audiocassette tape provide students with an introduction to basic concepts of energy forms, sources, and uses. After the presentation, students should have a basic understanding of the meaning of energy, with reference to the kinds of work done by the forces of energy. They should be aware of some of the main properties of energy: energy comes in many forms, such as heat, light, motion, or electricity; energy is produced from a variety of sources, such as wood, water, fossil fuels (coal, oil, natural gas), or sun; energy can be converted from one form to another; and energy conversion occurs in an energy system.

In this presentation, we have omitted certain concepts and scientific distinctions which we felt would unduly complicate the topic for students. To those teachers who wish to pursue this topic in greater depth and introduce classroom experiments and further explanatory material, the following resource documents are recommended:

Support documents to *The Formative Years*, a series dealing with the conservation of energy, provide information, student material, and suggestions to teachers for presenting this topic in the Junior Division. *What is Energy?* is especially recommended.

Water and Energy (J1)
Food and Human Energy (J2)
Clothing, Shelter, and Energy (J3)
Transportation and Energy (J4)
What Is Energy? (J5)
Air, Space Heating, and Energy Conservation (J6)
Manufacturing, Services, and Energy (J7)
Sources of Energy (J8)

Energy in Society is a resource guide produced by the Ministry of Education for teachers of the Intermediate and Senior Divisions in Ontario schools. The guide contains a wealth of material on the subject, including charts, graphs, energy games, and learning activities designed to help teachers in every discipline to

bring the problems of energy use or conversion into the classroom in a constructive and investigative way.

HOW TO PROCEED

Introductory Discussion

The color filmstrip and audiocassette tape in Part A are the core materials of the module. We have tried to keep the language level of the tapescript relatively simple and straightforward; however, the complex nature of the subject matter itself dictates a certain level of difficulty that cannot always be avoided.

We suggest, then, that the teacher conduct a brief introductory discussion with students before viewing the filmstrip, asking them what they know or think energy to be. Students could then list on the blackboard all the forms of energy they can name, giving brief descriptions for each. This activity will act as an advance organizer for students.

Depending on the students' level of comprehension, it may be useful to introduce some of the more difficult lexical items, phrases, and idioms from the tapescript.

Using the Tape

At three points in the tape, questions are directed to the students by the narrator. The teacher should stop the tape at these points and give students time to respond and discuss the point in question. Otherwise, the filmstrip is to advance one frame at the sound of the beep on the tape.

The teacher may wish to break up the filmstrip into two sections:

- Frames 1-36 deal with several easy-to-recognize energy forms;
- Frames 37 to the end focus on different forms of chemical energy and electrical energy, which may be more difficult for students to understand.

Energy Discussion

At the midpoint, after frame 36, it may be useful to go back to the list of energy forms developed before viewing the filmstrip, and expand and clarify that list. The list might now be done as a chart, giving the name of the energy form, a brief description, and one or two common sources. The information given here is not exhaustive. It merely provides a beginning step to the study of these phenomena.

Defining and describing forms of energy can be a complex and frustrating task as clear distinctions are often impossible. It may be sufficient at this stage if students understand the **work** done by different energy forms, without worrying about complex theoretical definitions.

The distinction between **source** and **form** can also be confusing. Coal is a **source** of energy. The **form** of energy stored in coal is called chemical energy. When coal is burned, the chemical energy is changed to light and heat, two other **forms** of energy.

Form of Energy	Description	Common Source
Kinetic	Energy of motion	Wind, waterfall
Heat (thermal)	Energy caused by the motion of molecules	Sun, fires, electric current
Sound	Energy caused by the vibration of air molecules	Motors, loudspeakers, musical instruments
Electric	Energy produced by the movement of electrons along a conductor	Falling water, steam and generator
Radiant (solar, light)	Energy that travels in visible and invisible light waves	Sun, fires, lightning, electric lights
Nuclear	Energy that is stored in the centre (nucleus) of every atom	Uranium
Chemical	Energy stored in the chemical composition of substances	Coal, wood, oil, food, matchtip
Potential	Energy that is stored up	Water tower, battery
Mechanical	Energy in the moving parts of an object or mechanism	Bicycle, car, machinery

Frame on Filmstrip

Transcript of Audiocassette Tape – Side 1

1. Title

2. Collage

Have you noticed that on radio and television, in newspapers and magazines, everyone seems to be talking about energy problems?

3. Balance

Will there always be enough gas to drive our cars? Will there be enough oil and gas to heat our homes? How can we cut down on energy costs?

4. Question

We hear a lot about it, but how much do we really know about energy? In this filmstrip, we will give you some facts about energy and what it does for us.

5. Marathon runners

What do you think of when you hear the word energy? Do you think of hard physical work, like running a race, or shovelling snow? These are examples of energy: human physical energy.

6. Flower
But there are many other kinds of energy. Think of a flower growing. We can't see this energy at work, but we can see changes in the plant as it grows. The invisible process going on inside the plant is the work of energy, just as it is for the person running.
7. Energy = Work
In fact, energy and work are so closely related that energy is often described as "the capability of doing work."
8. Energy forms
Energy has many forms. Some we can see, feel, or hear through our senses. Others are invisible. We can only sense the changes that take place, caused by the work of energy.
9. Conversion
When energy is at work it can change, or convert, to new forms that can be used more easily. This is energy conversion. One form of energy goes in; this is the input. It is changed in some way, and goes out in a new form, as the output.
10. Light bulb
Here is an energy conversion system. Can you name the input and the output of the system?
- (Stop tape to allow for responses.)
11. Flowchart
In the light bulb, the input is electrical energy, or electricity, and the new form of energy produced, the output, is light.
12. Flowchart
If you touch a light bulb that has been left on for some time, you will find that the bulb is hot. Heat has also been produced. We don't use this heat, so we call it a waste product.
13. Garden plot
Green plants are an example of a very special energy system. Plants convert energy from one form to another by a process called photosynthesis.
14. Photosynthesis
Through photosynthesis, plants use the radiant energy of the sun to make and store energy in the form of sugar and starch.
15. Market
The stored energy in plants is very important to humans. Plants provide us with nearly all the food we eat.
16. Lunch
Even when we eat meat, the animals have usually been fed on plant products. So the output of the plant system becomes the input for the human body system.
17. Human body system
When we eat, our body converts the stored energy in the food to heat and motion. Look closely at the diagram. Can you name the inputs, the outputs, and the waste products of the human body system?
- (Stop tape to allow for responses.)
18. Two workers
The amount of food energy we need depends on the physical work we do. Which of these two workers needs more food energy? You probably guessed the construction worker, and you're right.
19. Energy output
The harder we make our bodies work, the more physical energy we use, and the more food energy we need. If we measured energy in "hamburgers," you might use the food energy of one hamburger to walk for one hour, but you would need the energy of four hamburgers to run for one hour.

20. Radio and batteries Energy that is stored up, as it is in food, is called potential energy. A radio battery also has potential energy. The battery will hold its energy until you turn the radio on, and then it will release its energy.
21. Potential energy An object that is raised up in the air has potential energy, because it could do work if it were allowed to fall. Water before it goes over a waterfall has potential energy. This stone has potential energy.
22. Kinetic energy When the stone does fall, it has another form of energy — kinetic energy, or the energy of motion. There is kinetic energy all around us — a bouncing ball, a moving bicycle, or falling water, for example.
23. Sailboat A natural form of kinetic energy is the wind. We have depended on wind power for thousands of years to provide us with transportation.
24. Windmill Windmills are a common sight in many parts of the world today. As the wind turns the arms of the windmill, mechanical energy is produced to pump water, grind flour, or do other kinds of work.
25. Wind turbine In the future, the wind may again be an important energy source for us. Special windmills, like the one you see here, may provide us with a cheap and clean source of electricity.
26. Heat energy Heat is also a form of kinetic energy. Heat energy comes from the movement of the tiny particles, called molecules, in an object. The more heat energy there is, the faster the molecules move, or vibrate. The air molecules near a hot flame vibrate quickly, but farther away, where it is cooler, they vibrate more slowly.
27. Cooking Can you explain what happens when we heat our food?
- *(Stop tape to allow for responses.)*
28. Forest fire When we cook something, heat from the stove makes the food molecules vibrate faster and faster. More heat is produced and the food gets hot.
29. Radiant energy Heat is often linked with light energy. Think of a red-hot stove burner, a blazing fire, a candle flame. Each gives off light as well as heat.
30. Microwave oven Light energy is also called radiant energy. It is radiated, or sent out, from the sun, from lightning, from electric lights, and from fires.
31. Music group There are other forms of radiant energy we can't see, like radio waves, X-rays, and microwaves. Although we can't see this energy, we use it in equipment like X-ray machines and microwave ovens.
31. Music group Sound energy is a kind of kinetic energy. It comes from things that vibrate. When a guitar string is pulled, the energy released makes the air around it vibrate. Our ears can pick up the vibrations in the air and we hear a sound.

32. Setting sun
Much of the energy we have talked about so far comes directly from the sun — the oldest energy source of all. The sun's radiant energy, or solar energy, gives us heat and light. It also controls the power of the winds and the water.
33. Solar house
Today, with new technology, we can capture and store solar energy. We can use it for many of our needs, from tiny solar-powered calculators to solar-heated homes.
34. Solar truck wash
Solar energy is especially useful when large amounts of hot water are needed. Laundries, swimming pools, even this solar-heated truck wash are examples.
35. Street scene (dusk)
But solar energy is not always available. So, to have energy whenever and wherever we need it, we have found other ways to produce heat and light and fill our many energy needs.
36. Woodpile
Mostly, we depend on the chemical energy stored in fuels such as wood, coal, and oil. We can't see, hear, touch, or smell this energy until it is changed, or converted, to another form and put to work.
37. Burning match
A match tip contains stored chemical energy. When it burns, that energy is released and converted to energy in the form of heat and light.
38. Car engine
A car engine uses the chemical energy stored in gasoline.
39. Flowchart
The stored chemical energy is converted to heat energy, which in turn is converted to mechanical energy to make the car move.
40. Wood, coal, gas
The chemical energy stored in fuels can be in solid form, as in wood or coal. It can take the form of a gas, such as natural gas, which is often used for cooking and heating.
41. Crude oil
It can also be in liquid form, as in crude oil, or petroleum — dark liquid you see in the glass vial. We depend on petroleum for many of our energy needs today.
42. Fossil remains
Coal, oil, and natural gas are called fossil fuels because they were formed by fossils, the remains of plants and animals that died millions of years ago.
43. Fossil fuels
Heat and pressure over the years changed the fossil remains into hard deposits of coal, pockets of natural gas, and thick black crude oil.
44. Horsehead pump
The oil trapped deep in the earth can be pumped to the surface by pumps like these. Because they look a little like the heads of horses, they are often called "horsehead" pumps.
45. Refinery
Before we can use it, the crude oil has to be refined in an oil refinery. Here crude oil is changed into different forms to provide energy for our many needs.
46. Delivery truck
One product of the refinery is home heating oil. The oil truck delivering heating oil to our homes is a familiar sight in winter.
47. Traffic
We depend on fuels produced from crude oil for transportation. Gasoline is used to power the millions of cars that keep us all on the move.

48. Boeing 747
Buses, trains, trucks, and planes use huge amounts of fuel. One Boeing 747 "jumbo jet" can carry up to 170 000 litres of fuel!
49. Transmission tower
We do depend on fossil fuels. But there is another form of energy we depend on as well. This energy is invisible, like chemical energy, until it is released and put to work. It is electrical energy, or electricity.
50. Electricity
Electricity is a form of kinetic energy, since it is caused by the movement of electrons along a conductor, usually a piece of copper wire.
51. Uses of electricity
Electrical energy is versatile. It can be converted to light, heat, sound, and mechanical energy and put to use in our homes, at school, and in the community.
52. Kitchen appliances
Look around your kitchen. So many familiar objects are powered by electricity! As the electrical energy passes through motors, moving wheels, or heating coils, it is converted into mechanical, sound, or heat energy.
53. Trolley bus
Public transportation systems in our cities often depend on electricity to power streetcars, trolley buses, and even subways. Electricity comes to the trolley bus through wires overhead. It is converted to mechanical energy to power the vehicle.
54. Radio and batteries
Electrical energy can also be stored in batteries, as we saw before. The stored energy stays locked in the battery cells until it is converted to kinetic energy and used to light a bulb or power a transistor radio.
55. "Advantages"
With batteries, electricity can be used in places where there is no current electricity, where portable appliances are needed.
56. "Disadvantages"
Of course, batteries do not last forever. The stored energy is gradually used up.
57. Chain links
You have seen some common energy forms and how they are linked together in systems. Let's remember that we play an important part in the energy system too. We are the users of energy.
58. Students
Energy is vital to our world. And energy forms are closely linked. We must think about using energy wisely. The problem of conserving energy is not just a problem for others. It is something we can all do something about in our daily lives.
59. "End"

Part B: Follow-Up Activities

This section of the module includes a number of kinds of activities designed to incorporate review of content information, development of conceptual skills, and practice of language forms. Because the exercises vary in difficulty, the teacher may wish to omit certain exercises entirely and expand others to meet the needs of a particular class. The exercises need not be done in sequence as presented; however, we have placed the more difficult exercises — those relating to hypothetical thinking, for example — at the end of the module so that there is a form of progression from simple to more complex.

It may be necessary to replay the filmstrip-tape presentation several times in the course of completing the follow-up activities in order to ensure maximum comprehension and to review and reinforce the basic information presented. After completing the follow-up exercises, students should be able to approach the filmstrip-tape presentation with a much greater understanding of the basic principles of energy.

1. Energy Follow-Up

The first group of exercises reviews and reinforces the facts about the nature of energy through the use of text, diagrams, and charts. Worksheets 1 to 4 provide further practice in identifying energy forms, conversions, and systems. The crossword puzzle, Worksheet 5, reviews some of the important vocabulary, and Worksheet 6 is used with the audiocassette tape for listening practice.

As a preliminary or a follow-up to Worksheet 1, The Solar Energy Cycle, students should study the words:

nuclear energy
radiant energy
directly/indirectly
hydroelectric
atmosphere
radioactive

to depend on/rely on
reflected
decayed
remains
marine
fossil
technology

From what they have seen and read so far, have students develop simple definitions of:

solar energy
nuclear energy
hydroelectric power

fossil fuels
technological society

Have students use each term in a sentence.

Have students read the description of photosynthesis and label the diagram on Worksheet 2, using the terms given.

Have students describe orally the processes depicted in the two diagrams they have labelled. Students might take turns, each one describing one component of the diagram.

Instructions for worksheets 3, 4, and 5 are on the worksheets.

Worksheet 6 provides follow-up and review of the information content of the tape-filmstrip presentation, and practice in concentrated and purposeful listening. Ten brief situations have been recorded on Side 2 of the cassette tape. Each situation mentions or hints at the use of one or more energy forms. In most cases, several energy forms can be associated with the situation. Students are to listen carefully and write down on their answer sheets the energy form or forms involved in each situation. We suggest that a variety of responses be accepted in this exercise. In situation 1, for example, the simple response "food energy" should be accepted as well as the more technical term "chemical energy." Or in situation 2, "gas" as well as "chemical energy" should be accepted. Our aim is that students discover the wide variety of energy forms at work in simple daily situations.

The following is the transcript of the listening practice exercise on Side 2 of the cassette.

Listen carefully to the following situations. Each situation hints at the use of one or more energy forms. Write the energy form or forms on your answer sheet.

Let's do a practice example:

Example: "Your chicken soup is delicious."

Which energy forms are hinted at in this situation?

One is food energy. Soup provides us with energy. Also, it's a form of potential energy. Someone prepared the soup. This was human, or physical energy. Finally, electricity or gas. The soup was probably cooked on a gas or an electric stove. You could write food energy, potential energy, human energy, electricity or gas on your answer sheet.

You will hear each of the following situations read twice.

1. "Jack, I forgot to buy milk for the baby. Could you please go to the store for me? You'd better take the car. It's getting late."
2. "I'm sorry, but I don't want to live so close to the highway. The noise of the cars and trucks really bothers me."
3. "Don't forget to take a flashlight with you when you go camping."
4. "I don't feel like cooking inside today. It's too hot. Let's have a barbecue in the backyard."
5. "Joe, will you come over here and help me lift this crate out of the truck?"
6. "Janet, I've got a cake in the oven. Will you please run downstairs to the kitchen and see if it looks done? If it does, will you turn off the oven?"
7. "I am going to England tomorrow. This time I am not taking the plane. I'm going by boat. This way, I'll get time to rest on the way."
8. "This year I have planted tomatoes, beans, and lettuce in my garden. With all the warm weather and rain we've been having this summer, everything is growing like mad."
9. "I went to the races yesterday. You should have seen how fast those horses ran."
10. "You know, if you'd go and get the cart and stack those books into it, you wouldn't have so much trouble moving them."

To wind up the first group of exercises, students can create their own mini-situations to reflect practical examples of energy uses in daily life. The teacher could set this up as a game:

- Write the name of each energy form on a separate small cardboard card.
- Jumble the cards in a container of some sort.
- Have students, individually or in pairs, draw three cards out of the container.
- Have students create a mini-situation to include the three energy forms that are written on the cards they have drawn.
- Have the class vote on the most successful situation, the funniest situation, the most logical situation, etc.

Other project activities might include the following:

● Have students, individually or in pairs, choose a particular item they use for recreational purposes, such as roller skates, bicycles, or record players, and discuss what different forms of energy are used to operate each item. For example, in a record player, electricity makes moving parts turn and other parts vibrate (mechanical, kinetic energy) to produce sound; in roller skates, human, physical energy causes moving parts to turn (mechanical, kinetic) to produce motion.

● Have each student make a list of the machines he/she uses in a day. For each, the student should determine the form of energy used. The class as a group can then make a large graph to show the most common energy forms.

● Have students, individually or in groups, list

uses of the sun's energy in the past (in pioneer times, for example), in the present, and in the future (students should predict new ways of using the sun). If the interests of teacher and class run to art and collage, this could be followed by a class art project. Divide the class into three groups. Have each group depict a scene from the three time period (pioneer, present, and future) to illustrate energy use.

● In a class discussion, attempt a definition of energy pollution. Have students list examples of pollution related to energy use in their school surroundings, in the community, in the world.

● Have students start an energy scrapbook for future use to include newspaper clippings and magazine articles. Each student should decide on a particular focus for his/her book after consulting with the teacher.

● Turning off lights conserves energy. Have students design and write advertisements to encourage this and other ways of conserving energy. If drawn as posters, the ads could be displayed in the classroom or throughout the school.

2. Expressing Use and Need

USE

Before presenting these exercises, the teacher may first want to introduce the concept of use as an important part of a clearly written definition, and then present some of the appropriate language forms, in particular the infinitive and the gerund constructions after the verb *use*.

● When we describe an object, we often define it by stating what it is used for. For example:



A battery is a group of connected electric cells. It *is used to* provide electric energy for many portable appliances and devices.

● We can express the use of something in different ways.

Electricity *is used to light* the streets.
Electricity *is used for lighting* the streets.

Gasoline and diesel fuel *are used to power* cars, trucks, and buses.

Gasoline and diesel fuel *are used for powering* cars, trucks, and buses.

● Put the following five statements about the use of energy on the board and have students complete each sentence in two ways, using the infinitive and the gerund constructions. If written practice is needed, have students write out both forms of the sentences in their notebooks.

1. Wood and coal _____ (produce) heat.

2. Electrical energy _____ (power) radio, TV, and the telephone.

3. In former times, animal power _____ (do) heavy work.

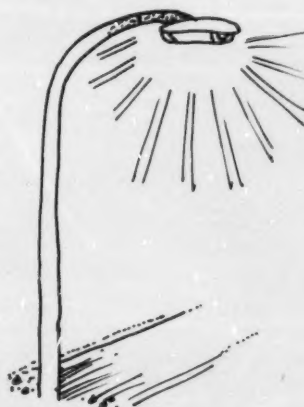
4. Crude oil _____ (make) plastic products.

5. Perhaps in the future solar energy _____ (heat) our homes and offices.

● Have students complete Worksheet 7, filling in the correct energy form and an appropriate form of the verb expressing use.

NEED

A description of an object often includes a statement about our need for it. For example:



A street light is an outdoor light fixture. It is usually constructed of a pole and incandescent lamp of some kind. We need street lights to make streets pleasanter and safer after dark.

● Three common verbs that express the need for something are: to need, to require, to depend on. For example:

Plants *need* solar energy in order to grow.
Streetcars *require* electricity to operate.
We *depend on* food for physical energy.

●Have students complete Worksheet 8, filling in the correct energy forms and the appropriate form of one of the three verbs expressing need.

●Have students complete Worksheet 9, composing a complete sentence to identify the energy form in the picture and what we use or need it for.

Note: In worksheets 7, 8, and 9, the verbs have been treated as vocabulary items only. No explicit reference to the passive voice has been made, since the focus of the activity is on learning how to express specific functions and not on active/passive transformations. The teacher may, of course, wish to use the exercises for the practice of active and passive constructions, especially if the students are already familiar with the active and passive.

Only a limited number of linguistic forms for the expression of use and need were presented in this activity. The teacher may wish to present a greater variety.

3. Describing Pictures

These exercises are meant to provide:

- a review of the information on energy forms and practice in recognizing different forms from visual presentations of their use
- an understanding of the concept of the changing significance of certain energy forms over the years
- an introduction to the concept of spatial organization as an aid to organize descriptive writing
- practice in vocabulary and linguistic structures related to the description of use and need
- stimulus for general conversation.

MATERIALS

Ten 8" × 10" photographs.

TASK

The exercises can be done orally, and then in writing. They can be done by the teacher with the entire class, by small groups of students working together, or by students working individually with minimum guidance from the teacher.

Students are asked to:

1. list all the energy forms they can detect in the picture
2. describe what the identified energy forms are used or needed for
3. verify, expand, and discuss their responses with a partner.

These three levels of activity constitute a breakoff system. The most proficient students will do all three, while the less proficient will complete only part 1, or parts 1 and 2.

PROCEDURE

●Arrange the photographs so that they are clearly visible to all students, or distribute them to small groups or to individual students.

●As students carefully examine the first photograph, introduce the concept of spatial organization as a logical principle of seeing and describing. The teacher should instruct students to start at a specified place in the photograph and move in a specified direction, preparing their lists in the order that elements of the photograph are spatially arranged. (Their descriptive sentences must follow this organizing principle as well.) For example, in photograph 1, students could look first at the front of the scene and then look farther back (up the street), or at the left side of the street and then the right.

●Using a fresh sheet of paper for each photograph, students first make a list of all energy forms they can detect in the photograph.

●Beneath the list of energy forms, have students write a complete sentence for each energy form listed, naming the form and describing its use.

●Correct the student sentences before proceeding to the final part of the activity, to avoid having students writing each other's mistakes.

●Students can work in pairs after they have completed their own sentences. They should compare lists and sentences with those of their partner. They should write down all the sentences from their partner's list. Then they should compare sentences that describe the same energy form, noting how different sentences can describe the same basic information.

Some suggested responses for photograph 1 are given in the Answer Key section at the back of this guide as a sample.

4. Energy for the Present

This section consists of a brief reading text (found in the student reading booklet *Energy for the Future*), which presents some facts and figures about energy resources and consumption in the province of Ontario and worldwide. The text gives a basis of factual information that can lead into a discussion of why conservation of energy resources is important, and in what areas it may be feasible.

Follow-up activities on worksheets 10-14 will give students practice in extracting detailed information from a written text, and in the skills of tabling and rank-ordering numerical information and preparing bar, line, and circle graphs.

The following are suggestions for using worksheets 10-14.

● World Oil Supply and Demand (Worksheet 12, #2)

— Discuss which method of presenting information makes it easier to see the relationship over time between two items.

— Hypothesize what might happen if there is not enough oil to go around.

● Oil Consumption in Ontario (Worksheet 13)

— Introduce the concept of the divided-circle graph. Go over with the class the mechanics of preparing the graph as indicated on the worksheet.

● Average Per Capita Oil Consumption (Worksheet 14)

— Discuss some reasons why Canadians use more primary energy per capita than citizens of any other large country, and why China, for example, uses so little in comparison. (Reasons include Canada's position as an industrial/technological society; its northern location; and the availability of human labor in China.)

GENERAL DISCUSSION QUESTIONS (Worksheets 10-14)

● In which area, or areas, would you start conserving the use of oil? Explain why.

● How do you think oil consumption could be reduced?

● What would be some of the effects of conservation?

● What are the pros and cons — that is, the advantages and disadvantages — of conserving in the way you suggest?

5. Energy for the Future

The booklet *Energy for the Future* also includes five reading selections.

The first reading selection, "Just an Ordinary Day," has been adapted from *Canada in View* (Toronto: McGraw-Hill Ryerson, 1978). It is a description of a normal working day in the year 2180, as imagined by a creative writer. The story is recorded on Side 2 of the audiocassette tape so that it can be used as a listening comprehension activity if the teacher so desires.

The following progression is suggested to the teacher:

— Have students listen to the story once for the general meaning.

— Have students listen to the story a second time, listing all the changes that have occurred in people's lives since the 1980s because of the lack of energy forms (no elevators, for example).

— Discuss with the class which energy forms have been depleted and which energy forms are still in use.

The second reading selection, "The Future of Energy," is adapted from a booklet prepared by the Imperial Oil Company called *Oil and Gas: Their Origin, Production, and Use*. This text presents a very different point of view from the first selection. The questions that follow will provide a framework for class discussion and comparison of the two points of view.

1. Is there an energy crisis or energy shortage?
 - (a) from the writer's point of view?
 - (b) from the scientist's point of view?
2. What are the two solutions offered?
3. Why is it important to conserve our fossil fuels (coal, oil, and natural gas)?
4. What alternative energy sources are mentioned?

The third selection, "It Doesn't Take Gas," was prepared by Ontario Hydro. This text should also be used as a reading comprehension exercise and as the basis for class discussion. It is suggested that the students' attention be directed to the pros and cons of electric cars and how contrasts are expressed linguistically (e.g., however, but).

	Advantages	Disadvantages
Active Solar System	– solar energy is <i>free</i> – <i>unlimited</i> – we can then use less fossil fuels (oil or gas, our non-renewable energy sources) – <i>clean</i> – doesn't pollute the environment	– expensive to install – needs extra solar equipment plus some form of auxiliary heating equipment (oil, gas, electricity) – large solar collectors seem unattractive
Passive Solar System	– needs no expensive equipment so is <i>not expensive</i> to install – doesn't pollute – <i>clean</i> – energy source is <i>free</i> – <i>unlimited</i> energy	– heat can't be stored efficiently for nighttime, cloudy days – house must be very well insulated

The fourth and fifth reading selections, "Solar Energy: A Feasible Alternative?" and "Making Solar Energy Work," are adapted from *Current: The Energy Newsletter for Teachers*, a component of Ontario Hydro's Energy Education Program. The two texts provide some basic information on this new and exciting energy prospect and open the way for further class discussion and project work on energy alternatives.

The chart (Worksheet 15) accompanies the text "Making Solar Energy Work," which describes the components of active and passive solar-heating systems.

● After they read the text and complete the chart, have students write one sentence for each part of the active solar system to describe its use. For example:

A solar collector captures (absorbs) the sun's radiation.

● Your students should now be able to make some statements about the advantages and disadvantages of active and passive solar systems. Discuss orally, and then have students prepare a chart listing the advantages and disadvantages of each system. The sample chart shown can serve as a guide.

6. Hypothetical Thinking; Electricity in the Home

The exercises and activities in this section are intended to provide grammatical practice in ex-

pressing the hypothetical and to provide source material for open-ended classroom discussions about the use of electricity and its costs. The sentence completion exercises will provide more structured practice with hypothetical clauses after the students have discussed the information on Worksheet 18.

DESCRIBING A HYPOTHETICAL SITUATION

Sometimes we imagine different situations and what we would do in those situations. We do not really expect that these situations will become real. They are hypothetical or unreal. In English we can express hypothetical situations in the following way:

If I had more energy, I would work harder.

If you want to ask questions about hypothetical situations, you can say:

What would happen *if* you had more energy?

or

What would you do *if* you had more energy?

You can reply: I would + verb . . . (as in example)

Note that to make a hypothetical statement, use the past tense in the *if*-clause and *would* + verb in the main clause.

Go over several examples with students such as these:

If-clause	Main clause
If I <i>had</i> a car	— I <i>would drive</i> to school.
If we <i>did not have</i> a car	— my father <i>would have to</i> take the subway to work
	— my father <i>could not drive</i> to work
	— my father <i>would not be able</i> to drive to work
If there <i>were</i> no schools	— we <i>would have to</i> study at home

Note that in the if-clause, the verb *to be* changes to *were* for all persons.

● Continue with Worksheet 16 for verb practice.

● Average Annual Consumption and Cost for Some Household Appliances

Using the list of questions provided and the table (worksheets 17 and 18), have the students consider some of the issues of cost and conservation reflected by these figures.

● Have them complete this section of activities with the sentence completion exercise on Worksheet 19.

● If possible, have students write a brief response to one or both of the following situations. They should try to use several hypothetical verb forms in their answers.

— How *would your* life change if we had no electricity?

— Gasoline has been rationed. What would you do to save on gasoline?

Useful Concepts and Terms

Chemical energy	A kind of stored energy that is released by chemical change.
Conduction	The transfer of heat or electrical energy through a substance.
Conserve	To use wisely and keep from becoming used up.
Conversion	The process of changing one energy form into another.
Electricity	A form of energy present in protons and electrons within atoms.
Electric power	The rate of transferring electric energy, expressed in watts, kilowatts, or megawatts.
Energy	The capability of doing work.
Evaporation	The transformation of water into vapor.
Fossil	What is left of a plant or animal that lived long ago.
Fuel	Anything that burns and gives heat energy.
Gas	A form of matter in which the molecules move about freely to take the shape of the entire container.
Hydroelectric generating station	A power station in which the force of falling water spins turbines that in turn drive electric generators.
Hydrologic cycle	The process by which water constantly circulates from the sea to the atmosphere to the earth, and back to the sea again.
Infra-red	Invisible radiation with a wave length greater than that of red light.
Insulation	A substance that slows down the flow of heat or sound.
Kilowatt (kW)	One thousand watts (a unit of electric power): $1 \text{ kW} = 1000 \text{ W}$.
Kilowatt hour (kW.h)	A unit of energy equal to the work done when energy is transferred at the rate of one kilowatt for one hour.
Kinetic energy	Energy possessed by moving objects.
Molecule	The smallest part of a substance that acts like the substance.
Nuclear energy	The energy released when an atom is split (fission).
Photosynthesis	The chemical process in plants that converts the radiant energy of sunlight into chemical energy using carbon dioxide and water molecules in the process. The resultant chemical energy may be stored in the plant as sucrose.
Pollution	The destruction of the purity of water or air by impairing its quality to a point where it becomes unfit for the many uses for which it is required.
Potential energy	Energy that is stored in a substance. One form of potential energy is gravitational potential energy, which is possessed by objects that can fall or travel closer to the earth's surface.
Power	The rate of doing work, or, in an electrical network, the rate at which electrical work is being supplied.
Reservoir	Water held in storage in either artificial or natural basins.
Sound energy	A kind of energy carried by vibrating molecules, which spreads out in wave fashion.

References and Resources

BOOKS

- Castner, H. W., and Mansfield, T. D. *Thinking about Ontario: A Hosford Study Atlas*. Toronto and Edmonton: Hosford, 1981.
- Corder, R. G., and Krueger, R. R. *Canada: A New Geography* (Rev. ed.). Toronto: Holt, Rinehart & Winston, 1974.
- Flanagan, F. J. *Focus on Science: Exploring the Physical World*. Toronto: D. C. Heath, 1979.
- Longfield, A., Wells, J., and Richer, K. *Science: The Nature of Things*. Toronto: Oxford University Press, 1981.
- Molyneux, J., and Olsen, M. *Canada in View*. Toronto: McGraw-Hill Ryerson, 1978.
- Orpwood, G. W. F., and Roberts, D. A. *Force and Energy: A Teacher's Manual for General Level Program Development*. Toronto: OISE, 1981.
- Wiley, W., Fryer, M. B., Girt, H., King, D., McLean, N., Thomas, G., and Welsh, A. *Canada: This Land of Ours* (Rev. ed.). Toronto: Ginn and Company, 1979.

BOOKLETS

Curriculum Ideas for Teachers. Toronto: Ministry of Education and Ministry of Energy, Ontario, 1981.

This series of documents dealing with the conservation of energy provides basic information, student material, and suggestions to the teacher for presenting this topic in the Junior Division. Titles in the series are:

- *Water and Energy* (J1)
- *Food and Human Energy* (J2)
- *Clothing, Shelter, and Energy* (J3)
- *Transportation and Energy* (J4)
- *What Is Energy?* (J5)
- *Air, Space Heating, and Energy Conservation* (J6)
- *Manufacturing, Services, and Energy* (J7)
- *Sources of Energy* (J8)

Energy in Society: A Resource Guide for Teachers. Ministry of Education and Ministry of Energy, Ontario, 1977.

This is a valuable resource booklet, prepared for the Intermediate and Senior Division, with detailed information on all major energy forms and their uses in today's society. The guide offers many suggestions for student activities as well as many il-

lustrations, statistical tables, and other information on energy.

Oil and Gas: Their Origin, Production, and Use. Toronto: Imperial Oil Ltd., 1979.

This booklet provides readable, clear, and concise information about petroleum and natural gas, their exploration, transportation, processing, and products, with a brief outlook on the future of energy. The booklet contains many illustrations. It can be recommended to teachers who wish to acquire fast background information and also to students for individual projects. The booklet can be obtained from: Imperial Oil Ltd., Customer Relations, 1 Duncan Mill Road, Don Mills, Ontario M3B 1Z2.

Ontario Energy Review (2nd ed.). Toronto: Ministry of Energy, Ontario, 1981.

This booklet provides concise textual and statistical (graphs and tables) information about Ontario's current energy sources, production, and consumption. Included also is information on alternative energy supplies, conservation practices or plans, and forecasts for the future. Recommended as up-to-date resource material for the teacher.

Available from: Ontario Government Bookstore, 880 Bay Street, Toronto, Ontario (in person); or Ontario Government Publications Service, 880 Bay Street, 5th Floor, Toronto, Ontario M7A 1N8 (by mail). Cheques or money orders should be made payable to the Treasurer of Ontario, and payment must accompany order. Price: \$2.50

Electricity, Past, Present and Future. Toronto: Ontario Hydro.

A brief history of generation of electricity, with a description of future alternatives such as solar, wind, and wood sources. A final note on conservation. Colored sketches. 20 pages. Large print. Grades 7-12.

This is useful additional reading material; language should be comprehensible to intermediate ESL level. Available from: Energy Education, Ontario Hydro, 700 University Avenue, 10th Floor, Toronto, Ontario M5G 1X6.

We'd Like to Know . . . Toronto: Ontario Hydro.

A compilation of questions people ask most often, ranging from technical information and government policy to conservation, alternative resources, and future plans. Sketches. 22 pages. Large print. Grades 7-12.

Useful as additional reading material for students (individually or in group/class). Available from Ontario Hydro (see address above).

EDUCATIONAL PROGRAMS FROM ONTARIO HYDRO

We wish to draw teachers' attention to the services and materials from Ontario Hydro's Energy Education Program, developed and managed by P. J. Spratt and Associates, Inc. The following teaching aids are provided free with workshop participation.

For information write to Energy Education, Ontario Hydro, 700 University Avenue, 10th Floor, Toronto, Ontario M5G 1X6, or call: (416) 598-1082.

1. Teaching Aids

Energy Plus

A set of introductory activities on the study of energy for levels K to 6 based on a multidisciplinary approach. The aid provides for high levels of active student participation.

Energy and Conservation

Designed for levels 4 to 8, these study units bring into focus everyday energy use. Provision is made for developing an appreciation of the role of energy in the students' environment.

Introduction to Electricity

Three sets of basic electricity experiments for levels 4 to 8, designed with an eye to the practical aspects of classroom learning. This aid makes use of students' visual and motor abilities.

Nuclear Science and Technology

Designed for levels 11 to 13, this aid is an intensive study of electricity production through nuclear generation.

Energy in the Canadian Environment

An aid for levels 7 to 10 that will highlight major energy considerations in the Canadian environment, focussing particularly on Ontario.

2. Films (See film section below)

3. Annotated Bibliography of Ontario Hydro

Generated reports and articles, e.g., on fossil fuels, renewable sources, management, and conservation. Bibliography is free; many reprints are also free.

4. Current

A magazine for Ontario teachers; free subscription, 6 issues per year, each focussing on a different energy-related topic.

5. In-service Workshops

Contact: Co-ordinator of Inservice Energy Education, Ontario Hydro, H10G3, 700 University Avenue, Toronto, Ontario M5G 1X6; (416) 598-1082.

These workshops present a background in basic concepts of energy. Participating teachers will receive *free resource materials* — for example, the teaching aids.

You may wish to approach your department head or co-ordinator to arrange for a workshop. Although the materials are not specifically designed for ESL students, most of them appear to be extremely useful and adaptable for different purposes.

It is also suggested that teachers who are interested in the energy topic check with Ontario Hydro about new materials developed. The Energy Education Program is an ongoing program, and new teaching aids on various topics are constantly being produced.

FIELD TRIPS

Pickering Nuclear Communication Centre

For information write to or call: Nuclear Communications Centre, Information Package, Pickering Nuclear Generating Station, Box 160, Pickering, Ontario L1V 2R5; (416) 839-0465.

The Nuclear Communications Centre is designed to provide the people of Ontario with a better understanding of Ontario Hydro's operations, the province's energy story, and the role of nuclear power. Displays, models, panels, videotapes, and computer games make exploration of the energy "mystery" interesting as well as informative.

The centre also offers illustrated lecture series for different age groups on a variety of energy sources. Energy films can be viewed, and a speaker is available to discuss the films.

Tours of the nuclear reactor can be arranged for grade 12 and 13 students.

Sir Adam Beck Generating Station (Niagara Falls)

Free Tours can be arranged through: H. I. Lloyd,
Corporate Relations Officer, Ontario Hydro, Box 157,
1053 Main Street W., Hamilton, Ontario L8N 3B9.

FILMS

The general criteria for selecting the films included in this bibliography are:

- relevant content
- appropriate level of presentation of scientific content
- appropriate language level for intermediate-level ESL students

The following films have been previewed and are suggested as follow-up materials.

As well, some additional films which may not meet all of the above criteria have been listed because of their high quality.

Films that are highly recommended are marked by an asterisk. In those cases special comments are included.

Films from Imperial Oil Ltd.

Films should be booked one month in advance. All are 16 mm. They will be delivered free, but the teacher has to arrange for their return. They are available on loan without charge from:

Association Films Ltd.
3rd Floor, 333 Adelaide St. W.
Toronto, Ont. M5V 1R6
(416) 362-2501

Modern Talking Picture Service
143 Sparks Ave.
Willowdale, Ont. M2H 2S5
(416) 498-7290

Imperial Oil Limited
P. O. Box 220
Halifax, N.S. B3J 2N6
(902) 424-6933

Imperial Oil Film Library
4980 Buchan Street
Montreal, P.Q. H4P 1S9
(514) 735-2246

Canfilm Screen Service Ltd.
583 Ellice Ave.
Winnipeg, Man. R3B 1Z7
(204) 786-6759

Canfilm Screen Service Ltd.
6814A 6th St. SE
Calgary, Alta. T2H 2K4
(403) 259-4444

Westcoast Audio-Visual Ltd.
Suite 101, 1600 West 6th Ave.
Vancouver, B.C. V6J 1R3
(604) 738-3161

**The Great Canadian Energy Saga* (27 minutes; grades 5-13)

An animated motion picture that lightheartedly demonstrates the importance of energy to Canadians past, present, and future. It shows how the energy search has taken explorers into the farthest frontiers and describes the necessity for continuous development if energy needs are to be met. Some of the energy forms introduced are muscle power, animal power, wind power, oil. All energy sources are covered in clear chronological order. Highly recommended as supplement to *The Many Faces of Energy*.

This film is also available from the Toronto Board of Education's Teaching Aid Department (for the board's teachers only).

**Leaving Something Over* (28 minutes; grades 9-13)

Demonstrates how easy it is to use energy more efficiently. Two families are faced with the problem of how to reduce their energy consumption. With the help of a mysterious third party they discover that saving energy can be a lot more fun than they thought. A teaching aid and other support material are available. Although the language and content details are at times complex, ESL students at the intermediate level should be able to follow. The film is of general value in terms of energy education and conservation.

A Mile below the Wheat (5 minutes; grades 5-13)

Tells the dramatic story of the discovery of oil at Leduc, Alberta, in 1947. The film is of historical value, and also shows the agricultural life in the west. It clearly depicts how crude oil is formed and drilled, and how a pipeline is built.

Backyard Bonanza (14 1/2 minutes; grades 5-13)

A do-it-yourself enthusiast plans to drill an oil well in his own backyard — until he finds out what is really involved. A simple explanation of how oil wells are drilled. The film is amusing and gives a realistic impression of the cost involved in drilling operations. Language is easy to understand.

Refinery

(13 3/4 minutes; grades 9-13)

The operations of a modern Canadian oil refinery and the safeguards it uses to protect the environment. Animated sequences show how crude oil is separated into various components and how molecules are sometimes recombined to produce various petroleum products, such as heating oil, gasoline, and jet fuel. Some details of the refinery operations may be difficult to understand. It is a good film, but recommended more for students with some science background.

Films from Ontario Hydro, Energy Education

To book films write to:

Energy Education
Ontario Hydro
700 University Avenue
10th Floor

Toronto, Ontario M5G 1X6

or call, with specific booking dates, (416) 598-2956 between 9 and 5 Monday to Thursday.

Films will be delivered free by courier anywhere in Ontario. Teachers are responsible for their return. All films are 16 mm and are accompanied by a free teacher's guide.

A Piece of Sunshine

(17 minutes; grades K-6)

A professor takes two children on a time tour of energy use from primitive times to the present and into the future. Introduction to energy concepts, forms, and sources and to energy conservation. Although the film was developed for younger grades and is spoken by children, it is not too childish. The language is very easy to understand. The energy content provides an excellent, easily comprehensible supplement to *The Many Faces of Energy*. Includes teacher's guide.

Waste Not, Want Not

(18 minutes; grades 8-12)

Future energy needs and supplies are examined in light of declining world energy reserves. The film stresses the need for conservation but leaves the audience to form its own conclusions. Language and content are complex. This film would be more appropriate for an advanced ESL class. Includes teacher's guide.

**Energy in Society*

(18 minutes; grades 7-10)

The film claims that we can maintain economic and industrial growth, preserve our standard of living, and at the same time reduce the growth of our energy demands by a variety of methods, including conserving energy in the home and community. Since the language is complex, the film is recommended for advanced ESL students. Includes teacher's guide.

Films from the Toronto Board of Education's Teaching Aids Department

The films are available on loan to teachers of the Toronto Board of Education only. It is suggested that teachers from other boards check the availability of these films with their own teaching aids department.

Learning about Solar Energy

(11 minutes; grades 3-6)

Through various experiments, children discover a relationship with current and potential uses of solar energy on a large scale. The language is very clear and easy to understand and can be recommended for beginning and intermediate ESL students. Although the film was originally intended for younger grades, it is not too childish for older students.

**Energy Management for the Future*

(25 minutes; grades 7-10)

Demonstrates that alternatives to our present wasteful energy habits do exist and that we must change from a consumer to a conserver society. The film unfolds a number of ideas and information on the subject. Through the use of animation and humor, it issues a warning that each of us must be responsible for our own energy consumption to ensure that our future needs are met.

Energy: Less Is More

(18 minutes; grades 9-13)

Investigates the need for slowing the growth of energy consumption and ways in which this can be done. Four principal areas are discussed: transportation, buildings, appliances, waste. The film presents good points of information which may stimulate further discussion among students. Recommended for intermediate to advanced ESL students.

Energy Dilemma

(18 minutes; grades 11-13)

A serious discussion of the energy crisis in Canada and the efforts being undertaken to meet it. Reviews the coal, fuel oil, and natural gas reserves in terms of future development, and their effect on the ecology of the country.

The language level is advanced. However, with teacher explanations and knowledge of the module *The Many Faces of Energy*, students should be able to comprehend the film.

Energy Carol

(11 minutes; grades 4-10)

Features Scrooge as the head of a power company who is visited by spirits of energy past, present, and future. Their alarming revelations motivate Scrooge to the point where he imposes the most severe and extensive restraints on the use of energy from his power company. Language is spoken very fast at times. Visual materials are good. With teacher's help intermediate ESL students should be able to understand the film.

Harness the Wind

(12 minutes; grades 4-13)

Traces the history of man's attempts to control and utilize wind energy. From the primitive wind machine of seventh-century Persia to the contemporary Darrieus rotor providing electricity to light 600 homes on the Magdalen Islands, the film outlines the gradual refinement of the windmill, showing how wind power has been proven to be an effective and increasingly efficient source of energy.

**The Great Search: Man's Need for Power and Energy*

(13 minutes; grades 4-8)

This film traces the human search for that undefinable force which moves the universe: energy. It shows the discovery, development, and application of the major sources of energy, and concludes by stressing the need to develop new power potentials that will not upset the ecological balance. The film is clear and amusing and can be highly recommended as follow-up material.

Energy and Matter

(9 minutes; grades 4-8)

An animated look at energy and what it is, designed to encourage understanding and experiment. The film emphasizes energy in familiar forms — light,

heat, motion, etc. — and shows its origin in the sun. In simple language, with good animation, the film presents a very simple introduction to energy concepts, forms, and sources. It is recommended for beginning and intermediate-level ESL students.

Churchill Falls: Power in Perpetuity

(22 minutes; grades 11-13)

The development of Canada's water resources is often spectacular in its magnitude. This film describes the harnessing of Churchill Falls in the wilds of Labrador. Because of its complex language, the film is only appropriate for advanced ESL level students.

Answer Key to Student Worksheets

THE SOLAR ENERGY CYCLE

Worksheet 1

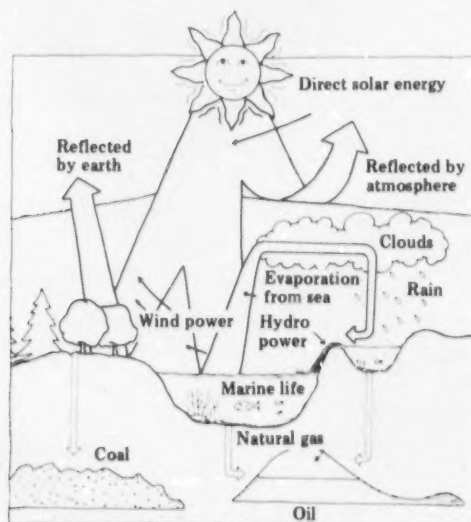
Read the description of the solar energy cycle, and label the diagram with the words and phrases given below.

The radiant energy of the sun gives us both heat and light. It makes all forms of life on Earth possible. At one time, people depended directly on the sun for their food, warmth, and light. Today we still depend on the sun, but indirectly. We use wind energy and water — hydro power, both controlled by the sun. We also rely on the sun's energy stored in the fossil fuels of the earth.

Much of the sun's direct energy does not even reach the earth: at least 30% is reflected away from the earth by the atmosphere, and a small amount is reflected away by the earth's surface itself. The solar energy that does reach the earth powers the winds and the water cycle. Solar energy is also used by plants and animals for growth. Plants need light to grow, and they are an important part of our food chain. We eat plant food ourselves, but we also eat animals that live on plants.

After millions of years, decayed remains of plant, animal, and marine life have produced the fossil fuels we depend on today. These fuels — coal, oil, and natural gas — make our modern technological society possible. Radioactive materials in the earth, such as uranium, can also be used as a fuel to provide nuclear energy.

So it is easy to see that, even though we do not always rely directly on heat and light from the sun, the effects of the sun's energy are still the building blocks of our entire energy system.



Direct Solar Energy
Wind power
Coal
Rain

Hydro power
Oil
Evaporation from sea
Reflected by earth

Marine life
Reflected by atmosphere
Clouds
Natural gas

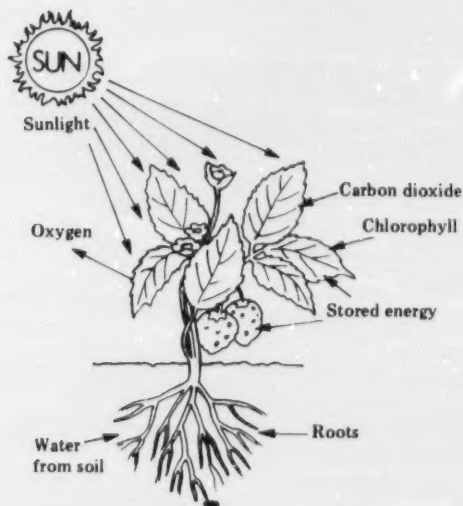
A PLANT'S ENERGY CONVERSION SYSTEM: PHOTOSYNTHESIS

Worksheet 2

Read the description of photosynthesis, and label the diagram below.

All green plants produce their own food, which they use for energy and for growth. In the leaves of every plant is a chemical called chlorophyll. This chemical enables the plant to use water from the soil, carbon dioxide from the air, and the energy in the sunlight that falls on it to make and store materials called carbohydrates. The carbohydrates are the food the plant uses as it grows new parts, such as leaves, roots, and flowers. The process of storing the energy of sunlight in carbohydrates is called photosynthesis.

During photosynthesis, plants give off oxygen as a waste. Thus, green plants produce not only food for themselves and for the animals that will eat them, but also the oxygen needed by all living things.



Sunlight
Oxygen

Water from soil
Carbon dioxide
Chlorophyll

Stored energy
Roots

FIVE ENERGY SYSTEMS

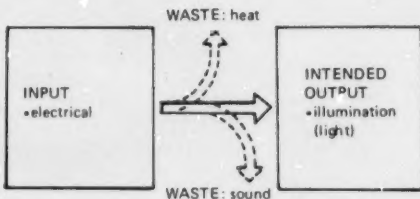
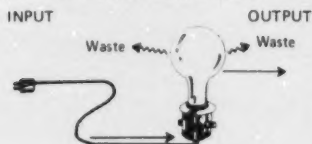
Worksheet 3

Energy conversion occurs in an energy system. Each system receives input and changes it to produce an output. At least one waste product is usually produced in this process.

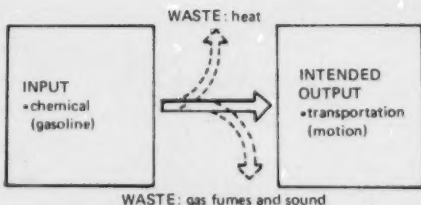
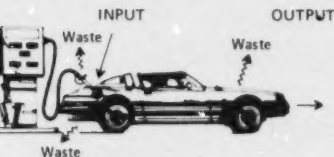
On the left are five energy systems. On the right, beside each system, is a flow chart diagram. Fill in the flow charts on the right by listing the energy input, the intended output, and the waste products of each system.

The first example is done for you.

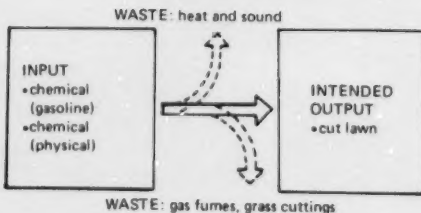
THE ELECTRIC LIGHT BULB SYSTEM



THE AUTOMOBILE TRANSPORTATION SYSTEM

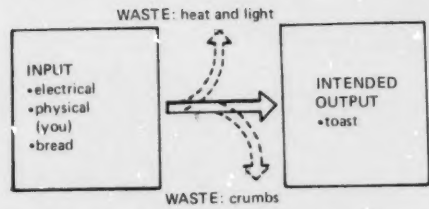


THE LAWN CUTTING SYSTEM



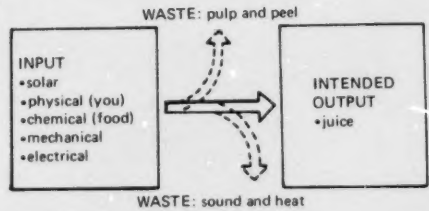
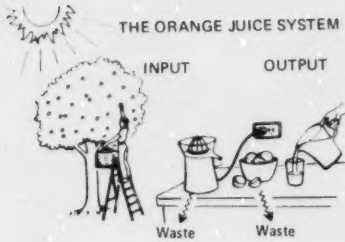
4.

THE BREAD TOASTING SYSTEM



5.

THE ORANGE JUICE SYSTEM



ENERGY CONVERSIONS

Worksheet 4

Most of the things we think of as users of energy are really converters of energy; they convert one form of energy into another form.

- In the table below, several energy converters are listed. Fill in the energy forms converted by these objects. The first example is done for you.

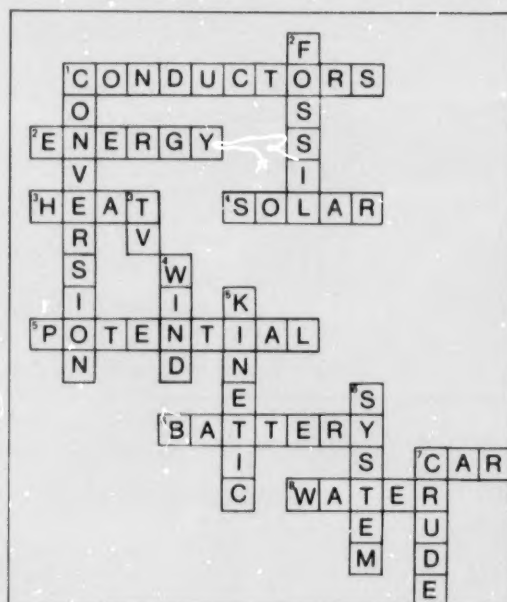
Converter of energy	Intended to convert	
	energy into	energy
automobile	chemical	kinetic/mechanical
bicycle	physical	kinetic/mechanical
radio	electrical	sound
gas furnace	chemical	heat
electric fan	electrical	mechanical/wind/kinetic
tomato plant	solar	food/chemical
hydro power station	water	electrical

- Make up five more examples of energy converters and the conversion they do.

--	--	--

ENERGY CROSSWORD PUZZLE

Worksheet 5



Across

1. All substances that transmit heat or electricity are called
2. is the capability of doing work.
3. A form of energy produced when fuel is burned.
4. The most ancient form of energy is energy.
5. Energy that is stored in a substance is called energy.
6. An object that produces and stores electrical energy.
7. A popular means of transportation powered by gasoline.
8. A renewable energy source that is commonly used to produce electricity.

Down

1. The process of changing one form of energy into another is called
2. Coal, oil, and natural gas are frequently called fuels.
3. An electrical appliance that provides entertainment in the home.
4. In the past, the energy of water and provided the power to turn waterwheel and windmills.
5. Energy possessed by moving objects is called energy.
6. Energy is converted from one form to another within the boundaries of an energy
7. Another name for petroleum is oil.

LISTENING PRACTICE

Worksheet 6

List the energy forms suggested in each situation.

Example:

- 1. *food, physical, mechanical, chemical, gas*
- 2. *mechanical, sound, gas, diesel fuel*
- 3. *light, radiant, electrical, potential, batteries*
- 4. *heat, thermal, electricity, fossil fuel, natural gas*
- 5. *physical, food, mechanical, diesel*
- 6. *chemical, food, heat, thermal, physical, electricity, gas, fossil fuel*
- 7. *jet fuel, mechanical, diesel, physical*
- 8. *chemical, food, radiant, light, solar, physical, photosynthesis*
- 9. *physical, animal, kinetic*
- 10. *physical, mechanical, kinetic*

SOME VERBS TO EXPRESS USE

Worksheet 7

Look carefully at each picture. Then complete the sentence with it with one of the verbs below to describe the energy form shown in the picture. Be sure to use the correct form of the verb.

Verbs: is/are used for
is/are used to

1.



In this picture, physical energy/animal power
(energy form)
is used to pull a heavy wagon.
(verb)

2.



Electrical energy
(energy form) is used for
(verb)
powering trolley buses.

3.



Sometimes wind (power)
(energy form) is used to
(verb)
produce electricity.

4.



These machines are examples of mechanical energy
(energy form)
such machines are used to help people
(verb)
do heavy work.

5.



Gasoline is a fuel that has chemical energy
(energy form)
It is used to power engines.
(verb)

SOME VERBS TO EXPRESS NEED

Worksheet 8

Look carefully at each picture on the left. Complete the sentence with one of the verbs you have studied to describe the energy form or forms shown in the picture.

Verbs: needs/need
 requires/ require
 depends on/depend on

1.



This boy needs physical energy to
(verb) (energy form)

ride his bicycle.

2.



Vacuum cleaners require electrical energy
(verb) (energy form)

to operate.

3.



Some water heaters depend on solar energy
(verb) (energy form)

for heating the water.

4.



Dancers need a great deal of physical
(verb) (energy form)

energy

5.



Our television sets depend on/need
(verb)

electrical energy to operate.
(energy form)

6.



A farmer depends on mechanical energy
(verb) (energy form)

to till the fields quickly and efficiently.

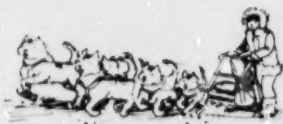
MAKING SENTENCES

Worksheet 9

Look carefully at the pictures on the left. Identify the energy forms shown in the pictures and write a sentence about their use or what we need them for. Use the verbs below. Be sure to use the correct form of the verb.

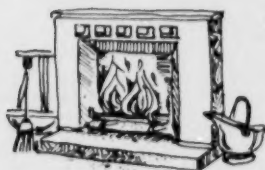
Verbs: is/are used to
is/are used for
needs/need
requires/require
depends on/depend on

1.



*In this picture, physical energy (animal power) is used
for pulling the sled.*

2.



*The chemical energy stored in wood is used to
produce heat and light.*

3.



This man depends on heat energy for his hot bath.

4.



This sailboat requires wind power to fill the sails.

5.



*In this picture, mechanical energy is used for
transporting fruit and vegetables, and muscle power
(physical energy) for pulling the cart.*

1. Using the information from Table 1 (below), label the divided-circle graph (Figure 1) to show the amount of energy consumed from each primary energy source.

Table 1. Canada's Primary Energy Sources 1979

Energy source	Amount consumed
Crude oil	42.8%
Water power	23.3%
Natural gas	19.0%
Coal	8.0%
Uranium	3.6%
Wood waste	3.3%
	100.0%

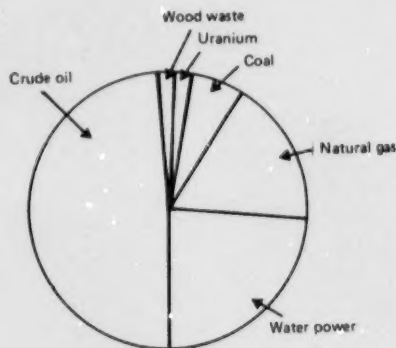


Figure 1. Canada's Primary Energy Sources 1979

2. Another way of representing Canada's energy consumption is by "slicing up" a barrel — the bigger the slice, the larger the amount of energy consumed. Label each slice with the appropriate energy source and percentage value as given in Table 1.

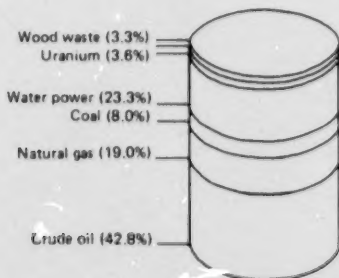


Figure 2. Canada's Primary Energy Sources 1979

1. Paragraph 3 of the booklet *Energy for the Future* gives you figures for world crude oil reserves as estimated in 1979. Complete the table below with the information given in the paragraph. Decide on a suitable title for the table.

Table 2. *Estimated World Crude Oil Reserves 1979*

Producer	%
Saudi Arabia	25
Other OPEC nations	43
Western non-OPEC nations (e.g., U.S.A., Canada)	18
Communist areas	<u>14</u>
	100

2. Draw a bar graph to illustrate the distribution of world crude oil reserves as estimated in 1979.

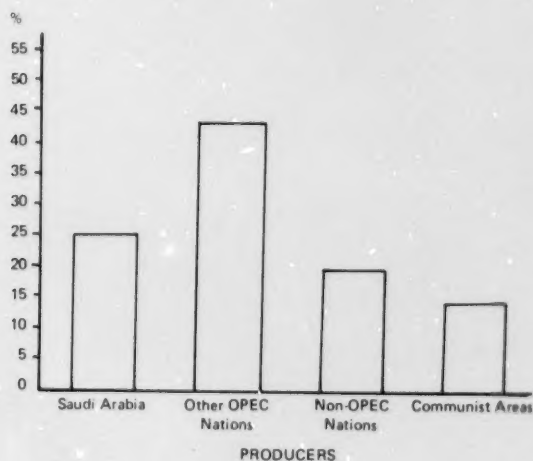


Figure 3.

DOUBLE-LINE GRAPH

Worksheet 12

Table 3 below tells us the forecast of world oil supply and demand for 1979, 1985, and 1990.

Table 3. Forecast of World Oil Supply and Demand
(million cubic metres per day)

	1979	1985	1990
World demand (excluding Communist countries)	8.2	9.3	10.3
World production	8.2	9.0	9.5

1. Draw a double-line graph to illustrate these figures. Use a solid line to indicate the demand, and a broken line to indicate the supply.

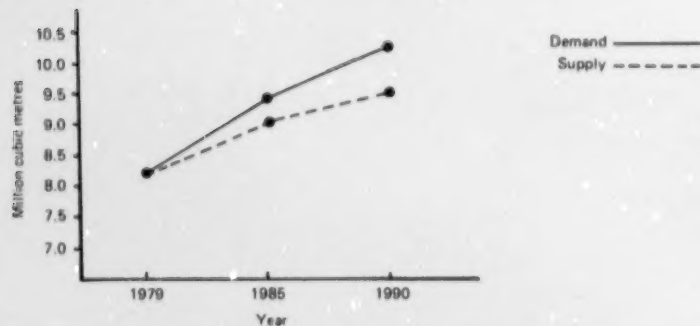


Figure 4. Forecast of World Oil Supply and Demand

2. Calculate the shortfall — that is, how many million cubic metres of oil per day we may be

short — by 1985 _____

by 1990 _____

DIVIDED-CIRCLE OR PIE GRAPH

Worksheet 13

1. Using the information about Ontario's oil consumption from the reading text, fill in Table 4 below with the types of use and the percentage of each type.
Convert each percentage value into degrees. There are 360° in a circle; therefore, 1% is equal to 3.6° ($360^\circ \div 100 = 3.6$). Enter all degrees into your table.

Table 4. Oil Consumption in Ontario 1979

Type of Use	%	Degrees in sector
Transportation	50	180
Residential	13	47
Industrial	10	36
Commercial	5	18
Oil refineries	10	36
Non-energy products	12	43
	100	360

2. Draw a circle in the space below with your compasses, and mark off each of the sectors with a protractor. Label each sector.

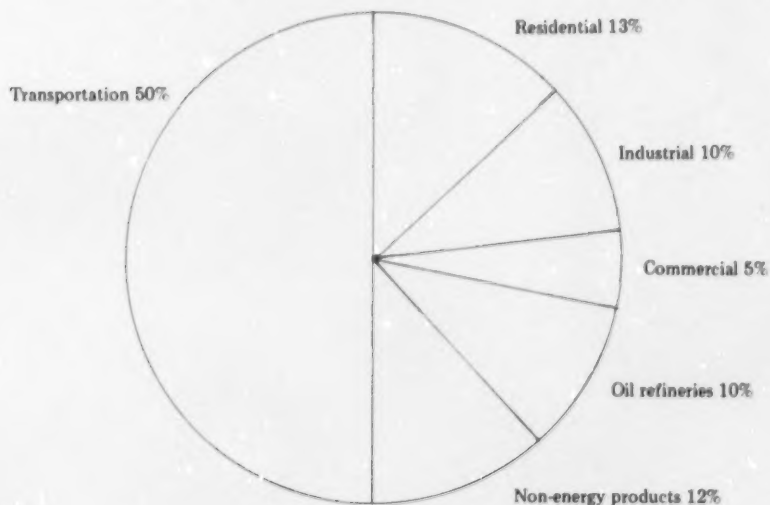


Table 5 below indicates the average amount of oil used annually by each person (per capita) in twelve countries around the world.

On the right-hand side of the table, rank order the information, putting at the top of the list the country that uses the most oil per capita, and ending with the country that uses the least oil per capita.

Table 5. Average Per Capita Oil Consumption in Twelve Countries

Country	Consumption per capita (barrels of oil)	Country	Consumption per capita (barrels of oil)
Spain	14.1	Canada	63.9
Netherlands	36.4	U.S.A.	58.4
West Germany	30.8	Netherlands	36.4
France	24.5	Sweden	36.0
Canada	63.9	West Germany	30.8
China	4.5	U.S.S.R.	29.5
Italy	17.4	United Kingdom	25.2
U.S.S.R.	29.5	France	24.5
Sweden	36.0	Japan	22.2
U.S.A.	58.4	Italy	17.4
Japan	22.2	Spain	14.1
United Kingdom	25.2	China	4.5

Source: BP statistical review of the world oil industry 1979; populations from the International Petroleum Encyclopedia 1980.

ACTIVE AND PASSIVE SOLAR SYSTEMS

Worksheet 15

Complete the chart below to show how active solar system is different from a passive system.

	Active	Passive
a) Mechanical equipment needed	— pumps and piping, or fans and ductwork	— no mechanical equipment
b) Solar collectors	— a flat, insulated box with a transparent cover — a solar plate inside the box	— windows facing south — stone or cement walls
c) Heat storage	— storage system (water or pebbles) — window shutters	— window shutters
d) Cost	— start at \$8000	— little additional cost

Fill in the blanks with the correct form of the verb.

1. If we *had* no crude oil, we could not produce plastic products.
(have)
2. We would have enough energy for the future if we *found* more energy sources.
(find)
3. If we *didn't have* heavy machinery, we would need a lot of muscle power to do
(have/not)
the work.
4. All life on earth would end if the sun *stopped* shining.
(stop)
5. We would save on gasoline if we *didn't use* our cars so often.
(use/not)
6. If we *didn't eat* , we *wouldn't have* any energy.
(eat/not) (have/not)
7. Everybody *would have to* walk more if we *didn't have* any
(have to) (have/not)
means of transportation.
8. If gasoline *were* rationed, we *would not drive* our cars
(be) (drive/not)
as much as we do today.
9. If Canadians *conserved* more energy, we *would* possibly *become*
(conserve) (become)
self-sufficient.
10. Our heating costs *would decrease* if we *lowered* our thermostats.

DISCUSSION QUESTIONS

Worksheet 17

1. Look down the list of appliances on Worksheet 18. Which ones are the most expensive to use?
2. Check off the expensive appliances that you have in your home and add up the total annual cost.
3. Add up the entire list of appliances. What would be the total cost in a home which had every single appliance listed?
4. Check off all the appliances that are used for cooking. Add up the cost of electricity for these cooking appliances.
5. If you wanted to save money and electricity, which of the cooking appliances could you do without? Why?
6. Look at the cost of electricity in the refrigerators and deep freezers. Add up the total for these appliances.
7. If you wanted to save money and electricity, which refrigerator or deep freeze would you buy? How much would you save by your choice?
8. Look down the list of appliances again and check off at least three appliances that you think are completely non-essential in a home. Don't include the cooking or refrigerating appliances that you have talked about already. What other ways can we do the same things without using the appliances you have checked?

AVERAGE ANNUAL CONSUMPTION AND OPERATING COST
OF SOME HOME APPLIANCES

Worksheet 18

Appliance	Estimated annual consumption (kW.h)	Estimated annual energy cost*
Air conditioner (6000 BTU).....	500	\$ 20.00
Car block heater.....	500	20.00
Clock.....	18	.72
Clothes dryer.....	900	36.00
Coffee maker.....	100	4.00
Dehumidifier.....	400	16.00
Dishwasher (not including hot water).....	300	12.00
Electric blanket.....	125	5.00
Electric kettle.....	150	6.00
Electric shaver.....	12	.48
Electric stove.....	1200	48.00
Electric water heater.....	6000	240.00
Food waste disposer.....	25	1.00
Fryer (deep fat).....	70	2.80
Frying pan.....	180	7.20
Grill (sandwich).....	30	1.20
Fan (furnace).....	800	32.00
Hair dryer.....	36	1.44
Humidifier.....	200	8.00
Iron.....	120	4.80
Kitchen fan.....	50	2.00
Mixmaster.....	25	1.00
Radio (tube type).....	100	4.00
(solid state).....	10	.40
Refrigerator (12 cubic feet).....	850	34.00
Refrigerator (frost free — 12 cubic feet).....	1200	48.00
Freezer (14 cubic feet).....	1200	48.00
Freezer (frost free — 14 cubic feet).....	1600	64.00
Sewing machine.....	10	.40
Television (black and white).....	350	14.00
Television (color).....	450	18.00
Toaster (pop-up).....	40	1.60
Vacuum cleaner.....	40	1.60
Washing machine (wringer — not including hot water).....	50	2.00
Washing machine (automatic — not including hot water).....	90	3.60

Sources: *100 Ways to Save Energy and Money in the Home* (Ottawa: Office of Energy Conservation, Energy, Mines and Resources Canada, 1976; *How You Use the Electricity You Use* (Toronto: Ontario Hydro, 1981).

*Based on an average of 4¢/kilowatt hour (kW.h) for Ontario residential customers.

COMPLETE THE SENTENCES

Worksheet 19

Keeping in mind the cost of electricity for many household appliances, complete the sentences below.

- 1 If we wanted to save money and electricity on cooking appliances, ...
- 2 If we wanted to save money and electricity on refrigerators and deep freezers, we
- 3 If we wanted to save money and electricity on the furnace bill, we
- 4 If we didn't use a food waste disposer, we
- 5 If we didn't use an electric blanket in the winter, we
- 6 If we wanted to save money and electricity on hot water heating, we
- 7 If I were worried about buying an economical television set, I

Suggestions for Photograph 1 (p. 11)

1. Human energy (muscle power, physical energy, chemical energy)
2. Electrical
3. Mechanical
4. Chemical (gasoline)
5. Chemical (heating oil)
6. Wind
7. Solar